Research Area

Pain research and TMS facility

Pain research and TMS facility has been in the forefront since 2012 to alleviate the pain of the patients suffering from various pain syndromes especially those which are chronic in nature. Since the time of its inception we have tried to decode the intricacies of the pain matrix and the neural areas involved in its perception , modulation , assessment and relief in human subjects Transcranial magnetic stimulation (TMS) is a focal non-invasive form of brain stimulation technique based on the principles of electromagnetic induction (Barker et al., 1985). Application of short magnetic pulses over the scalp of subject induces electrical current in the neurons of the cortex. Initially approved for treatment of depression by FDA the technique has now emerged as a non-invasive method of stimulating brain areas and revolutionized our understanding of neurophysiology. TMS has now found place in management of chronic pain and disability. Research over the years highlight the endeavours of the lab in pain assessment and management. In order to understand the mechanism of action of pain relieving modalities it is pertinent to first understand the pathophysiology and methods of assessment of pain in humans. The patients are routinely referred from Neurology ,Physical medicine and rehabilitation , Trauma centre, Cancer clinics and Rheumatology clinics. The methods to subjectively and objectively assess pain have been introduced in patients of chronic pain patients such as tension type headache, migraine , fibromyalgia ,low back pain and cancer pain

Subjective assessment of pain:

A battery of standard questionnaires and scores are utilized to study various aspects of chronic pain and associated symptoms i.e. McGill Pain Questionnaire (MGQ), Hamilton Depression Rating Scale (HAM-D), Hamilton Anxiety Rating Scale (HAM-A), Pain coping strategy questionnaire (CSQ), Pain belief questionnaire (PBQ), WHO Quality of Life-BREF Questionnaire (WHOQOL-BREF) and Visual analogue scale. These questionnaires are converted in Hindi language for Indian patients.

Objective assessment of pain:

Quantitative sensory testing

Quantitative sensory testing (QST) is a non-invasive test to assess somatosensory perception of individuals by application of various stimuli at controlled intensities. QST can serve as a valuable tool not only in assessment of the individual's sensory profile but understanding underlying mechanisms of pain. QST can be used to detect somatosensory aberrations that may contribute to the individual's experience of pain and disability. The battery of tests involved are used for evaluation of function of large (A beta) and small (A-delta and C) nerve fibers also, ascending pathways of sensory perception. There are two forms of QST tests: Static and dynamic quantitative sensory testing. Static QST helps in assessment of sensory perception; whether the subject is able to detect a particular stimulus (detection threshold), at what intensity of stimulus he/she reports first pain (pain threshold) and till what limit the subject can tolerate the stimulus (pain tolerance threshold). Static QST consists of estimation of thresholds for various modalities like mechanical, thermal, pressure, vibration, chemical, electrical etc. Thresholds for particulars stimuli can help assess both inadequate function (hypoalgesia- decreased sensitivity to painful stimuli) as well as gain of function (hyperalgesia- increased sensitivity to feeling pain and an extreme response to pain). Peripheral sensitization is an increase in the excitability of nociceptors which leads to neuroinflammation .

Dynamic QST helps in assessment of central pain modulatory pathways primarily ascending facilitation of pain. Dynamic QST is one such test, that can probe both ascending facilitation

and descending modulation of incoming nociceptive signals via Temporal summation (TS) and Conditioned Pain Modulation (CPM) respectively. The impact of dysfunctional pain modulatory processes can be investigated and help in addressing whether medications that improve CLBP outcomes exert effects on endogenous pain modulation or not. The quantitative sensory outcomes can significantly influence management strategies for various pain syndromes. (Walk et al, 2009).The current research thus aimed to assess peripheral and central sensitization in Fibromyalgia, chronic low back pain, rheumatoid arthritis, cancer pain patients using static and dynamic quantitative sensory testing.

Electrophysiological studies:

Nociceptive Flexion Reflex (RIII Reflex)

NFR was first standardized in human subjects and then in patients of fibromyalgia (AD), the pain was objectively evaluated by nociceptive flexion reflex (RIII) and confirmed by visual analogue scale (VAS). It was found all fibromyalgia patients showed attenuation of response. The NFR recording technique has proven to be quick, simple, reliable and reproducible in patients of chronic pain NFR used as a tool to study pain modulation:

Pain inhibitory pathways: Diffuse noxious inhibitory controls (DNIC)

In our laboratory, endogenous pain modulation systems/DNIC is studied by exploring the effect of noxious cold stimulus, mental task, deep pressure pain (pressure at tendon Achilles), on the characteristics of R-III reflex. Such studies were conducted in tension type headache fibromyalgia patients and the results were compared with healthy control subjects. It was observed that there is involvement of central pain modulating mechanisms in chronic pain states

Pain facilitatory Pathways : Temporal summation

Thermal testing quantitatively measures thresholds for warmth, cold, heat-induced pain and cold induced pain and then compares them to age-matched normal population values. A deviation from the normal range is observed in chronic pain patients indicating aberrations in pain facilitatory pathways. This was used to record pain ratings, thermal sensation, thermal pain and summation of pain in various chronic pain syndromes.

Electromyography (EMG) of muscles

Electromyography of pericranial and cervical muscles was also done to assess role of muscle spasm in chronic tension type headache and we reported overactivity of temporalis, frontalis and trapezius muscles in headache patients which was relieved by yoga therapy and the results were comparable to non steroidal anti inflammatory drugs . Botulinum toxin was also injected in pericranial muscles to relieve pain although the muscles became flaccid when their EMG was analyzed but the subjective experience of pain was unaffected.

Transcranial magnetic stimulation (TMS) as an interventions for Chronic Pain

In line with our ultimate goal of alleviating patient's pain, restore and enhance their quality of life, we explored Transcranial magnetic stimulation (TMS) as a possible therapeutic and exploratory tool. Since 2008, after its approval by FDA, we started using TMS as an intervention for various kinds of pain disorders such as Fibromyalgia, chronic tension-type headache, migraine, patients with spinal cord injury and other pain disorders.

TMS as an intervention for Fibromyalgia

In our laboratory, a study was conducted to study the effect of chronic exposure to magnetic field on pain status of fibromyalgia patients. We used a figure-of-8/ butterfly stimulating or sham coil to target the desired brain area. The patients were divided into two groups: real rTMS and Sham rTMS. In these patients, rTMS were given for one month, 5days per week; 0.5 Hz frequency at the DLPFC. Patients were followed up to six months. It was found that for chronic pain assessment, both Sham and TMS groups have higher VAS score of pain than controls as well as greater score for anxiety, depression and worse quality of life than the control groups. rTMS caused significant improvement in pain and pain related emotions (depression, anxiety) and quality of life. Similarly, for acute pain assessment, RIII reflex data showed that the pain threshold was significantly lower in Sham and rTMS groups in comparisons to controls which was increased after rTMS therapy

Transcranial Magnetic Stimulation for other chronic pain conditions

Non-invasive brain stimulation , TMS is being used to treat the cases of fibromyalgia, Low backache , Chronic headaches, Rheumatoid arthritis. For this, we have divided the patients in to two groups: real rTMS and sham group in our projects. These patients received TMS therapy for one month for 5 days per week with each session lasting about 35-40 mins. Till now, the real rTMS patient groups have shown promising improvements in pain rating and other related symptoms after treatment.

Augmenting rTMS with Neuronavigation (NeNa)

Transcranial Magnetic Stimulation (TMS) delivers short magnetic pulses that penetrate the skull unattenuated, disrupting neural processing in a noninvasive, reversible way. To disrupt specific neural processes, coil placement over the proper site is critical. Therefore, a neural navigator (NeNa) is being used to target specific brain areas for rTMS. NeNa is a frameless stereotactic device using structural and functional magnetic resonance imaging (fMRI) data to guide TMS coil placement. In human subjects, consistent efforts are put forward towards understanding the etiology of pain syndromes such as orthodontic Pain, fibromyalgia, chronic

low back pain, chronic tension type headache. We have standardized the use of rTMS for eliciting motor evoked potentials (MEP) and record sensory changes in masticatory muscles using heat evoked potentials. This technique is a potential therapeutic intervention for the treatment of psychiatric and neurological disorders which possibly can be a novel paradigm to unravel the various neuroadaptive mechanisms of the brain in pain.